



AbstractPlus

BROWSE

SEARCH

IEEE Xplore GUIDE

[View Search Results](#) | [Previous Article](#) | [Next Article](#)
 e-mail

## Document options

Full Text: PDF (454 KB)

## Download this citation

 Choose  
Download 
[» Learn More](#)

## Rights &amp; Permissions


[» Learn More](#)

## Watershed-driven relaxation labeling for image segmentation

Hansen, M.W. Higgins, W.E.

David Sarnoff Res. Center, Princeton, NJ, USA;

 This paper appears in: **Image Processing, 1994. Proceedings. ICIP-94., IEEE International Conference on**  
 Publication Date: 13-16 Nov. 1994

Volume: 3

On page(s): 460 - 464 vol.3

Meeting Date: 11/13/1994 - 11/16/1994

Location: Austin, TX

INSPEC Accession Number:5027269

DOI: 10.1109/ICIP.1994.413764

Posted online: 2002-08-06 19:11:51.0

## Abstract

Introduces an image **segmentation** method referred to as **watershed**-driven relaxation labeling. It is a hybrid **segmentation** process utilizing both **watershed** analysis and relaxation labeling. **watershed** analysis is used to subdivide an image into catchment basins, effectively clustering pixels based on their spatial proximity and intensity homogeneity. Classification estimates in the basins are set for each of these catchment basins. Relaxation labeling is then used to iteratively refine the classifications of the catchment basins through propagating constraints and utilizing local information. The relaxation updating process is continued until a large majority of the catchment basins are correctly classified. The method provides fast, accurate **segmentation** results and exploits the individual strengths of **watershed** analysis and relaxation labeling. The robustness of the method is illustrated through comparison to other popular **segmentation** techniques.

## Index Terms

Inspec

## Controlled Indexing

catchment basins classifications hybrid segmentation process image classification image segmentation intensity homogeneity iterative methods local information propagating constraints relaxation theory robustness spatial proximity updating process watershed analysis watershed-driven relaxation labeling

## Non-controlled Indexing

catchment basins classifications hybrid segmentation process image classification image segmentation intensity homogeneity iterative methods local information propagating constraints relaxation theory robustness spatial proximity updating process watershed analysis watershed-driven relaxation labeling

## Author Keywords

Not Available

## References

No references available on IEEE Xplore.

## Citing Documents

- 1 Image segmentation and analysis via multiscale gradient watershed hierarchies, Gauch, H., *Image Processing, IEEE Transactions on*, Vol. 8, No. 1, Jan 1999  
 On page(s): 69-79, Volume: 8, Issue: 1, Jan 1999  
[Abstract](#) | [Full Text: PDF \(1732\)](#)

2 Relaxation methods for supervised image segmentation, Hansen, M.W.; Higgins, W.E.  
*Pattern Analysis and Machine Intelligence, IEEE Transactions on*  
On page(s): 949-962, Volume: 19, Issue: 9, Sep 1997  
[Abstract](#) | [Full Text: PDF \(652\)](#)

[◀ View Search Results](#) | [◀ Previous Article](#) | [Next Article ▶](#)

[Help](#) [Contact Us](#) [Privacy](#)

© Copyright 2005 IEEE



## Document options

 Full Text: [PDF](#) (454 KB)

## Download this citation

 Choose [Citation](#) 

 Download [EndNote, ProCite, RefMan](#) 
[» Learn More](#)

## Rights &amp; Permissions


[» Learn More](#)

## Cooperation of color pixel classification schemes and color watershed: a study for microscopic images

Lezoray, O. Cardot, H.

Lab. Univ. des Sci. Appliques de Cherbourg, France

 This paper appears in: **Image Processing, IEEE Transactions on**  
 Publication Date: July 2002

Volume: 11, Issue: 7

On page(s): 783 - 789

ISSN: 1057-7149

INSPEC Accession Number: 7354093

DOI: 10.1109/TIP.2002.800889

Posted online: 2002-11-07 17:08:47.0

## Abstract

We study the ability of the cooperation of two-color pixel classification schemes (Bayesian classification) with color watershed. Using color pixel classification alone does not suffice to extract color regions so we suggest to use a strategy based on three steps: simplification, color watershed. Color watershed is based on a new aggregation function using local and global criteria. This strategy is performed on microscopic images. Quantitative measures are used to evaluate the quality of the segmentations according to a learning set of reference images.

## Index Terms

Inspec

## Controlled Indexing

[Bayes methods](#) [image classification](#) [image colour analysis](#) [image segmentation](#) [microscopy](#)

## Non-controlled Indexing

[Bayesian classification](#) [K-means classification](#) [aggregation function](#) [color pixel classification](#) [color regions extraction](#) [color watershed](#) [global criteria](#) [image segmentation](#) [learning set](#) [local criteria](#) [microscopic images](#) [reference images](#)

## Author Keywords

Not Available

## References

1. Y.-I. Ohta, T. Kanade, and T. Sakai, "Color information for regions segmentation," *Comput. Vis. Image Process.*, vol. 13, pp. 222-241, 1980.  
[\[Buy Via Ask\\*IEEE\]](#)
2. M. Celenk, "A color clustering technique for image segmentation," *Comput. Vis. Graph. Image Process.*, vol. 52, pp. 145-170, 1990.  
[\[Buy Via Ask\\*IEEE\]](#)
3. E. Littman and E. Ritter, "Color image segmentation: A comparison of neural and statistical methods," *Trans. Neural Networks*, vol. 8, pp. 175-185, Jan. 1997.  
[\[Abstract\]](#) [\[Full Text: PDF \(256KB\)\]](#)
4. P. Campadelli, D. Medici, and R. Schettini, "Color image segmentation using Hopfield neural networks," *Comput. Vis. Image Process.*, vol. 15, no. 3, pp. 161, 1997.  
[\[CrossRef\]](#) [\[Buy Via Ask\\*IEEE\]](#)
5. A. Trémeau and N. Borel, "A region growing and merging algorithm to color segment microscopic images," *Image Processing, IEEE Transactions on*, vol. 11, no. 7, pp. 783-789, July 2002.  
[\[CrossRef\]](#) [\[Buy Via Ask\\*IEEE\]](#)

*Recognit.*, vol. 30, no. 7, pp. 1191-1203, 1998.  
[\[CrossRef\]](#) [\[Buy Via Ask\\*IEEE\]](#)

6 V. Cappellini, K. N. Platanitis, and A. N. Venetsanopoulos, "Applications of color image processing to medical image analysis," in *Proc. Int. Conf. Digital Signal Processing*, 1995.  
[\[Buy Via Ask\\*IEEE\]](#)

7 G. N. Papanicolaou, "A new procedure for staining vaginal smears," *Science*, vol. 95, pp. 11-21, 1940.  
[\[Buy Via Ask\\*IEEE\]](#)

8 O. A. Verevka, "Color image quantization in windows systems with local \$k\$-means algorithm," in *Western Computer Graphics Symp.*, 1995, pp. 74-79.  
[\[Buy Via Ask\\*IEEE\]](#)

9 S. J. Wan, P. Prusinkwicz, and S. K. M. Wong, "Variance-based color image quantization for display," *Color Res. Applicat.*, vol. 15, no. 1, pp. 52-58, 1990.  
[\[Buy Via Ask\\*IEEE\]](#)

10 R. S. Gentile, J. P. Allebach, and E. Wallowitz, "Quantization of color images based on uniform quantization," *J. Imag. Sci. Technol.*, vol. 16, no. 1, pp. 11-21, 1990.  
[\[Buy Via Ask\\*IEEE\]](#)

11 S. E. Umbaugh, R. H. Moss, W. V. Stoecker, and G. A. Hance, "Automatic color segmentation with application to skin tumor feature identification," *IEEE Eng. Med. Biol. Mag.*, vol. 12, no. 1, pp. 12-17, 1993.  
[Abstract](#) | Full Text: [PDF](#) (788KB)

12 G. Wyszecki and W. S. Styles, *Color Science: Concepts and Methods, Quantitative Data and Formulae*, 2nd ed. New York: Wiley, 1982.  
[\[Buy Via Ask\\*IEEE\]](#)

13 L. Shafarenko, M. Petrou, and J. Kittler, "Automatic watershed segmentation of textured images," *Trans. Image Processing*, vol. 6, pp. 1530-1543, Nov. 1997.  
[Abstract](#) | Full Text: [PDF](#) (568KB)

14 O. Lezoray, A. Elmoataz, H. Cardot, and M. Revenu, "Segmentation of cytological images using mathematical morphology," *Acta Stereol.*, vol. 18, no. 1, 1999.  
[\[Buy Via Ask\\*IEEE\]](#)

15 L. Cohen, L. Vinet, P. T. Sander, and A. Gagalowicz, "Hierarchical regional based stereological segmentation," in *Proc. Computer Vision and Pattern Recognition*, 1989, pp. 416-421.  
[Abstract](#) | Full Text: [PDF](#) (624KB)

16 L. Vinet, *Segmentation et mise en correspondance de régions de paires d'images stéréologiques*, dissertation Paris, France: Dauphine Univ. Paris IX, 1991.

17 H. W. Kuhn, "The Hungarian method for the assignment problem," *Naval Res. Logist. Quart.*, vol. 2, pp. 83-97, 1955.  
[\[Buy Via Ask\\*IEEE\]](#)

18 F. Meyer, "Color image segmentation," in *Proc. Int. Conf. Image Processing Applications*, 1998, pp. 303-306.  
[Abstract](#) | Full Text: [PDF](#) (276KB)

19 P. Belhomme, A. Elmoataz, P. Herlin, and D. Bloyet, "Generalized region growing operation for image scanning: Application to segmentation of breast cancer images," *J. Microsc.*, vol. 186, pt. 1, pp. 1-10, 1997.  
[\[Buy Via Ask\\*IEEE\]](#)

20 K. Saarinen, "Color image segmentation by a watershed algorithm and region adjacency graph processing," in *Proc. ICIP*, vol. 3, 1994, pp. 1021-1025.  
[Abstract](#) | Full Text: [PDF](#) (428KB)

21 O. Lezoray, A. Elmoataz, H. Cardot, and M. Revenu, "A color morphological segmentation method," in *Proc. Conf. Color in Graphics and Image Processing*, 2000, pp. 170-175.  
[\[Buy Via Ask\\*IEEE\]](#)

22 L. Vincent and P. Soille, "Watersheds in digital spaces: An efficient algorithm based on simulations," *IEEE Trans. Pattern Anal. Machine Intell.*, vol. 13, pp. 583-598, June 1991.  
[Abstract](#) | Full Text: [PDF](#) (1792KB)

23 A. Cumani, P. Grattoni, and A. Giuducci, "An edge-based description of color images," *Graph. Image Process.*, vol. 53, no. 1, pp. 313-323, 1991.

[\[Buy Via Ask\\*IEEE\]](#)

24 C. Drewniok, "Multi-spectral edge detection: Some experiments on data from landsat-t *Sens.*, vol. 15, no. 18, pp. 3743-3765, 1994.  
[\[Buy Via Ask\\*IEEE\]](#)

25 S. DiZzenzo, "A note on the gradient of a multi-image," *Comput. Vis., Graph., Image Pr.* 116-126, 1986.  
[\[Buy Via Ask\\*IEEE\]](#)

26 O. Lezoray, A. Elmoataz, H. Cardot, and M. Revenu, "Arctic: An automatic cellular sort image analysis," in *Proc. Vision Interface Trois-Rivières*, QC, Canada, 1999.  
[\[Buy Via Ask\\*IEEE\]](#)

27 F. Catte, F. Dibos, and G. Koepfler, "A morphological scheme for mean curvature motion to anisotropic diffusion and motion of level sets," *SIAM J. Numer. Anal.*, vol. 32, no. 6, 1995.  
[\[Buy Via Ask\\*IEEE\]](#)

28 F. Ortiz, F. Torres, S. Puente, F. Candelas, and P. Gil, "Use of the hue/saturation/intensity morphological processing of color images," in *Proc. Int. Conf. Color in Graphics and Imaging* 2000, pp. 219-224.  
[\[Buy Via Ask\\*IEEE\]](#)

29 A. Hanbury, *Lexicographical Order in the HLS Colour Space* Paris, France: Centre de Mathématique, École des Mines de Paris, Tech. Rep., 2001.

#### Citing Documents

No citing documents available on IEEE Xplore.

◀ [View Search Results](#) | [Next Article](#) ▶

[Help](#) [Contact Us](#) [Privacy](#)

© Copyright 2005 IEEE

Indexed by  



[Home](#) | [Login](#) | [Logout](#) | [Access Information](#) | [Alerts](#)

Welcome United States Patent and Trademark Office

 AbstractPlus[BROWSE](#)[SEARCH](#)[IEEE Xplore Guide](#)
[◀ View Search Results](#) | [◀ Previous Article](#) | [Next Article ▶](#)
 e-mail
**Document options**
 Full Text: [PDF](#) (454 KB)
**Download this citation**Choose [Citation](#) Download [EndNote, ProCite, RefMan](#)
[» Learn More](#)
**Rights & Permissions**
[» Learn More](#)
**Model-based morphological segmentation and labeling of angiograms**

Haris, K. Efstratiadis, S.N. Maglaveras, N. Pappas, C. Gourassas, J. Louridas, G. Lab. of Med. Inf., Aristotelian Univ. of Thessaloniki, Greece;

This paper appears in: **Medical Imaging, IEEE Transactions on**  
 Publication Date: Oct. 1999

Volume: 18 , Issue: 10  
 On page(s): 1003 - 1015  
 ISSN: 0278-0062  
 CODEN: ITMID4  
 INSPEC Accession Number: 6470563  
 DOI: 10.1109/42.811312  
 Posted online: 2002-08-06 22:57:09.0

**Abstract**

A method for extraction and labeling of the coronary arterial tree (CAT) using minimal user single-view angiograms is proposed. The CAT structural description (skeleton and borders) with quantitative information for the artery dimensions and assignment of coded labels, based on a coronary artery model represented by a graph. The stages of the method are: (1) CAT tracking; (2) artery skeleton and border estimation; (3) feature graph creation; and (iv) artery labeling. The approximate CAT centerline and borders are extracted by recursive tracking based on homotopy analysis. The accurate skeleton and borders of each CAT segment are computed, based on homotopy modification and watershed transform. The approximate centerline and borders are constructed by constructing the artery segment enclosing area (ASEA), where the defined skeleton and borders are considered as markers. Using the marked ASEA, an artery gradient image is constructed. The pixels (except the skeleton ones) are assigned the gradient magnitude of the original image. The gradient image markers are imposed as its unique regional minima by the homotopy modification. The watershed transform is used for extracting the artery segment borders, and the feature graph is created. Finally, given the created feature graph and the known model graph, a graph matching algorithm is used to assign appropriate labels to the extracted CAT using weighted maximal cliques on the association graph corresponding to the two given graphs. Experimental results using clinical digitized coronary angiograms are presented.

**Index Terms**

Inspec

**Controlled Indexing**

[angiography](#) [diagnostic radiography](#) [edge detection](#) [feature extraction](#) [gradient](#) [image segmentation](#) [medical image processing](#) [physiological models](#)

**Non-controlled Indexing**

[artery labeling](#) [artery segment enclosing area](#) [artery skeleton estimation](#) [border detection](#) [clinical digitized coronary angiograms](#) [coronary angiograms labeling](#) [coronary artery model](#) [feature graph creation](#) [graph matching](#) [homotopy modification](#) [image segmentation](#) [medical diagnostic imaging](#) [model-based morphological segmentation](#) [morphological segmentation](#) [morphology modification](#) [regional minima](#) [watershed transform](#)

**Author Keywords**

Not Available

**References**

1 P. J.de Feyter, C. D.Mario, and P. W.Serruys, *Quantitative Coronary Imaging*. Rotterdam:

Netherlands: Barjesteh, Meeuwes & Co., 1995.

- 2 H. A. Fozzard, E. Haber, R. B. Jennings, A. M. Katz, and H. E. Morgan, *The Heart and Circulatory System: Scientific Foundations.*, New York: Raven Press, vol. I, 1992.
- 3 K. M. Detre, E. Wright, M. L. Murphy, and T. Takaro, "Observer agreement in evaluating angiograms," *Circulation*, vol. 52, pp. 979-986, 1975.
- 4 T. A. D. Rouen, J. A. Murray, and W. Owen, "Variability in the analysis of coronary arteriograms," *Circulation*, vol. 55, pp. 324-328, 1977.
- 5 T. Saito, M. Misaki, K. Shirato, and T. Takishima, "Three-dimensional quantitative coronary angiography," *IEEE Trans. Biomed. Eng.*, vol. 37, pp. 768-777, Aug. 1990.  
[Abstract](#) | [Full Text: PDF \(816KB\)](#)
- 6 M. Garreau, J. L. Coatrieux, R. Collorec, and C. Chardenon, "A knowledge-based approach to reconstruction and labeling of vascular networks from biplane angiographic projections," *IEEE Trans. Med. Imag.*, vol. 10, pp. 122-131, June 1991.  
[Abstract](#) | [Full Text: PDF \(1012KB\)](#)
- 7 L. V. Tran, R. C. Bahn, and J. Sklansky, "Reconstructing the cross sections of coronary angiograms," *IEEE Trans. Med. Imag.*, vol. 11, pp. 517-529, Dec. 1992.  
[Abstract](#) | [Full Text: PDF \(1112KB\)](#)
- 8 I. Liu and Y. Sun, "Recursive tracking of vascular networks in angiograms based on the medial axis scheme," *IEEE Trans. Med. Imag.*, vol. 12, pp. 334-341, June 1993.  
[Abstract](#) | [Full Text: PDF \(1084KB\)](#)
- 9 S. Y. J. Chen and C. E. Metz, "Improved determination of biplane imaging geometry from angiograms and its application to three-dimensional reconstruction of coronary arterial trees," *IEEE Trans. Med. Imag.*, vol. 16, pp. 633-654, May 1997.  
[\[CrossRef\]](#)
- 10 T. V. Nguyen and J. Sklansky, "Reconstructing the 3-D medial axes of coronary arteries from cineangiograms," *IEEE Trans. Med. Imag.*, vol. 13, pp. 61-73, Mar. 1994.  
[Abstract](#) | [Full Text: PDF \(976KB\)](#)
- 11 W. Xia and W. Lu, "Correspondence analysis for regional tracking in coronary angiograms," *IEEE Trans. Med. Imag.*, vol. 11, pp. 153-160, June 1992.  
[Abstract](#) | [Full Text: PDF \(524KB\)](#)
- 12 B. C. S. Tom, S. N. Efratiaidis, and A. K. Katsaggelos, "Motion estimation of skeletonized coronary angiograms using elastic registration," *IEEE Trans. Med. Imag.*, vol. 13, pp. 450-460, Sept. 1994.  
[Abstract](#) | [Full Text: PDF \(872KB\)](#)
- 13 T. L. Faber, J. L. Klein, R. D. Folks, J. G. Hoff, J. W. Peifer, E. J. Malveaux, C. D. Cooke, and J. A. Gammie, "Automatic unification of three-dimensional cardiac perfusion with three-dimensional coronary angiograms," *Proc. Computers Cardiology'96*, pp. 333-336, 1996.  
[Abstract](#) | [Full Text: PDF \(528KB\)](#)
- 14 T. N. Pappas and J. S. Lim, "A new method for estimation of coronary artery dimensionality," *IEEE Trans. Acoust., Speech, Signal Processing*, vol. 36, pp. 1501-1513, Sept. 1988.  
[Abstract](#) | [Full Text: PDF \(1176KB\)](#)
- 15 P. Besl and R. Jain, "Segmentation through variable-order surface fitting," *IEEE Trans. Pattern Anal. Machine Intell.*, vol. 10, pp. 167-192, Mar. 1988.  
[Abstract](#) | [Full Text: PDF \(3320KB\)](#)
- 16 M. A. Figueiredo and J. M. Leitao, "A nonsmoothing approach to the estimation of vessel profiles in coronary angiograms," *IEEE Trans. Med. Imag.*, vol. 14, pp. 162-172, Mar. 1995.  
[Abstract](#) | [Full Text: PDF \(1432KB\)](#)
- 17 M. Sonka, C. J. Wilbricht, S. R. Fleagle, S. K. Tadikonda, M. D. Winniford, and S. M. Collins, "Robust simultaneous detection of coronary artery borders and vessel profiles in coronary angiograms," *IEEE Trans. Med. Imag.*, vol. 12, pp. 588-599, Sept. 1993.  
[Abstract](#) | [Full Text: PDF \(1472KB\)](#)
- 18 M. Sonka, M. D. Winniford, and S. M. Collins, "Robust simultaneous detection of coronary artery borders and vessel profiles in coronary angiograms," *IEEE Trans. Med. Imag.*, vol. 14, pp. 151-161, Mar. 1995.  
[Abstract](#) | [Full Text: PDF \(1344KB\)](#)
- 19 A. K. Klein, F. Lee, and A. A. Amini, "Quantitative coronary angiography with deformable models," *IEEE Trans. Med. Imag.*, vol. 16, pp. 468-482, Oct. 1997.

[Abstract](#) | Full Text: [PDF \(308KB\)](#)

- 20 M.Hart and L.Holley, "A method of automated coronary artery tracking in unsubtracted *Computers Cardiology'93*, pp. 93-96, 1993.  
[Abstract](#) | Full Text: [PDF \(372KB\)](#)
- 21 S.Lu and S.Eiho, "Automatic detection of the coronary arterial contours with sub-branc angiogram," *Proc. Computers Cardiology'93*, pp. 575-578, 1993.  
[Abstract](#) | Full Text: [PDF \(232KB\)](#)
- 22 A. C.Dumay, J. J.Gerbrands, and J. H.Reiber, "Automated extraction, labeling and ana vasculature from arteriograms," *Yearbook Med. Informatics*, pp. 353-363, 1996.
- 23 G.Coppini, M.Demi, R.Poli, and G.Valli, "An artificial vision system for X-ray images of tree," *IEEE Trans. Pattern Anal. Machine Intell.*, vol. 15, pp. 156-162, Feb. 1993.  
[Abstract](#) | Full Text: [PDF \(784KB\)](#)
- 24 P.Hall, M.Ngan, and P.Andreae, "Reconstruction of vascular networks using three-dim *IEEE Trans. Med. Imag.*, vol. 16, pp. 919-929, Dec. 1997.  
[Abstract](#) | Full Text: [PDF \(212KB\)](#)
- 25 C.Pisupati, L.Wolff, W.Mitzner, and E.Zerhouni, "Geometric tree matching with applica structures," *Proc. ACM Symp. Computational Geometry* Philadelphia, PA, 1996.
- 26 C.Smets, F.van der Werf, P.Suetens, and A.Oosterlinck, "An expert system for the lab reconstruction of the coronary arteries from two projections," *Int. J. Cardiac Imag.*, vol. 1990.
- 27 D.Ballard and C.Brown, *Computer Vision*. Englewood Cliffs, NJ: Prentice-Hall, 1982.
- 28 N.Ezquerro, S.Capell, L.Klein, and P.Duijves, "Model-guided labeling of coronary struc *Med. Imag.*, vol. 17, pp. 429-441, June 1998.  
[Abstract](#) | Full Text: [PDF \(220KB\)](#)
- 29 C.Chalopin, I. E.Magnin, and G.Finet, "Automatic labeling of the coronary tree using a reference prior model," *Proc. Computers Cardiology'98*, pp. 761-764, 1998.
- 30 K.Haris, S. N.Efstratiadis, N.Maglaveras, J.Gourassas, C.Pappas, and G.Louridas, "Ar extraction using watersheds," *Proc. Computers Cardiology'97*, pp. 741-744, 1999  
[Abstract](#) | Full Text: [PDF \(472KB\)](#)
- 31 K.Haris, S. N.Efstratiadis, N.Maglaveras, J.Gourassas, C.Pappas, and G.Louridas, "Co extraction based on artery tracking and mathematical morphology," *Proc. Computers C*, pp. 769-772, 1998.
- 32 Y.Sun, "Automated identification of vessel contours in coronary arteriograms by an ad algorithm," *IEEE Trans. Med. Imag.*, vol. 8, pp. 78-88, 1989.  
[Abstract](#) | Full Text: [PDF \(1456KB\)](#)
- 33 J.Serra, *Image Analysis and Mathematical Morphology*. London, U.K.: Academic, 1982.
- 34 L.Vincent and P.Soille, "Watersheds in digital spaces: An efficient algorithm based on simulations," *IEEE Trans. Pattern Anal. Machine Intell.*, vol. 13, pp. 583-598, June 1991  
[Abstract](#) | Full Text: [PDF \(1792KB\)](#)
- 35 L.Najman and M.Schmitt, "Geodesic saliency of watershed contours and hierarchical s *Trans. Pattern Anal. Machine Intell.*, vol. 18, pp. 1163-1173, Dec. 1998.  
[Abstract](#) | Full Text: [PDF \(1668KB\)](#)
- 36 K.Haris, S.Efstratiadis, N.Maglaveras, and A. K.Katsaggelos, "Hybrid image segmenta watersheds and fast region merging," *IEEE Trans. Image Processing*, vol. 7, pp. 1684-1694, Sept. 1998.
- 37 F.Meyer and S.Beucher, "Morphological segmentation," *J. Visual Commun. Image Re*, Sept. 1990.
- 38 L.Vincent, "Morphological grayscale reconstruction in image analysis: Applications and results," *IEEE Trans. Image Processing*, vol. 2, pp. 176-201, Aug. 1993.  
[Abstract](#) | Full Text: [PDF \(3416KB\)](#)
- 39 P. M. J.der Zwet, M.Nettesheim, J. J.Gerbrands, and J. H.Reiber, "Derivation of optim detection of coronary arteries," *IEEE Trans. Med. Imag.*, vol. 17, pp. 108-120, Feb. 1998.  
[Abstract](#) | Full Text: [PDF \(380KB\)](#)
- 40 J. T.Dodge, G.Brown, E.Bolson, and H. T.Dodge, "Intrathoracic spatial location of spec

segments of the normal human heart," *Circulation*, vol. 78, no. 1, pp. 1167-1180, 1988

41 J. T.Dodge, G.Brown, E.Bolson, and H. T.Dodge, "Lumen diameter of normal human c  
Influence of age, sex, anatomic variation, and left ventricular hypertrophy or dilation," (c  
pp. 232-246, July 1992.

42 P.Suetens, P.Fua, and A. J.Hanson, "Computational strategies for object recognition,"  
*Surveys*, vol. 24, Mar. 1992.  
[CrossRef]

43 P. M.Pardalos and J.Xue, "The maximum clique problem," *J. Glob. Optim.*, vol. 4, pp. 1  
44 R.Horaud and T.Skordas, "Stereo correspondence through feature grouping and maxi  
*Trans. Pattern Anal. Machine Intell.*, vol. 11, pp. 1168-1180, Nov. 1989.  
Abstract | Full Text: PDF (1220KB)

45 R.Carraghan and P. M.Pardalos, "An exact algorithm for the maximum clique problem,  
vol. 9, pp. 375-382, 1990.

#### Citing Documents

1 Evaluation of center-line extraction algorithms in quantitative coronary angiography, G  
Laifenfeld, M.; Einav, S.; Barnea, O.  
*Medical Imaging, IEEE Transactions on*  
On page(s): 928-941, Volume: 20, Issue: 9, Sep 2001  
Abstract | Full Text: PDF (368)

◀ [View Search Results](#) | ▲ [Previous Article](#) | [Next Article](#) ▶

[Help](#) [Contact Us](#) [Privacy](#)

© Copyright 2005 IEEE

Indexed by  
 Inspec


[Home](#) | [Login](#) | [Logout](#) | [Access Information](#) | [Alerts](#)

Welcome United States Patent and Trademark Office

AbstractPlus

BROWSE

SEARCH

IEEE Xplore GUIDE

[View Search Results](#) | [Previous Article](#) | [Next Article](#)
 e-mail

## Document options

Full Text: PDF (454 KB)

## Download this citation

Choose  Download 
[» Learn More](#)

## Rights &amp; Permissions


[» Learn More](#)

## An improved watershed algorithm for counting objects in anisotropic 3-D biological images

Ancin, H. Dufresne, T.E. Ridder, G.M. Turner, J.N. Roysam, B.

Dept. of Electr. Comput. &amp; Syst. Eng., Rensselaer Polytech. Inst., Troy, NY, USA;

This paper appears in: **Image Processing, 1995. Proceedings., International Conference on**  
Publication Date: 23-26 Oct. 1995

Volume: 3

On page(s): 172 - 175 vol.3

Meeting Date: 10/23/1995 - 10/26/1995

Location: Washington, DC

INSPEC Accession Number:5256014

DOI: 10.1109/ICIP.1995.537608

Posted online: 2002-08-06 20:10:56.0

**Abstract**

Effective 3-D image processing algorithms are presented for automatic counting and analysis of anisotropic 3-D biological images that are collected by laser-scanning confocal microscopes. The instruments, the x-y resolution is much better than the resolution along the z axis, hence the images (3-D) are anisotropic. In this work, the images are pre-processed by a 3-D extension of an anisotropic diffusion algorithm, and the resulting images are binarized by a clustering based segmentation algorithm. The resulting binary segmentation, some regions consist of individual objects while others are multi-object clusters. The watershed algorithm (1991) to anisotropic 3D spaces is used to find such cell clusters. The watershed algorithm is applied on marker functions that are generated by a combination of 3-D morphological inverse distance functions and 3-D image gradients. Characteristics such as volume, average intensity and locations, are calculated on the result of watershed segmentation. This algorithm has been successfully applied to the automated analysis of cell populations from biological studies involving large numbers of tissue samples.

**Index Terms**

Inspec

**Controlled Indexing**
[biological techniques](#) [biology computing](#) [cellular biophysics](#) [image reconstruction](#)  
[resolution](#) [image segmentation](#) [mathematical morphology](#) [optical microscopy](#)
**Non-controlled Indexing**
[3-D image gradients](#) [3-D morphological inverse distance functions](#) [anisotropic 3-D](#)  
[anisotropic diffusion algorithm](#) [automatic counting](#) [average intensity](#) [binary segmentation](#)  
[cell analysis](#) [cell clusters](#) [clustering based segmentation algorithm](#) [effective 3-D](#)  
[image processing algorithms](#) [image pre-processing](#) [improved watershed algorithm](#) [in](#)  
[objects](#) [laser-scanning confocal microscopes](#) [marker functions](#) [multi-object clustering](#)  
[anisotropic 3-D biological images](#) [object counting](#) [resolution](#) [voxels](#) [watershed segmentation](#)
**Author Keywords**

Not Available

**References**

No references available on IEEE Xplore.

**Citing Documents**

No citing documents available on IEEE Xplore.

[◀ View Search Results](#) | [◀ Previous Article](#) | [Next Article ▶](#)

[Help](#) [Contact Us](#) [Privacy](#)

Indexed by  
 Inspec

© Copyright 2005 IEE